



Project Oops! I Dropped Something!



We've all done it-dropped something that ended up broken as a result.

You might be tempted to blame gravity.

But if gravity always exists, why doesn't everything you drop break?

We're not the first ones to be faced with this question. People have careers thanks to gravity. In this project, you'll get a taste of what some of those careers may entail.

Maybe you'll even find a way to defy gravity!

Name _____ Block _____

Teammate(s) _____

Start at: _____

Science: Computers & LT 5&6

Technology: Desks

Engineering: Hall

Math: Lab Tables 1-4

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SCIENCE

Today was the day Mrs. Graveson was supposed to teach the class about gravity and potential and kinetic energy so you would be prepared to SKYPE with an astronaut. But...Mrs. G was called away at the last minute to fly on the Vomit Comet! Luckily, Mrs. G found some great substitutes: Jon Bergmann, from TEDEd, and Nick and Jane, from Brick University. Watch their presentations (on Mrs. Graveson's Class Summary webpage) to answer the following questions so you can be prepared to SKYPE!

<http://www.douglas.k12.ma.us/webpages/kg Graveson/resources.cfm>



GRAVITY (Guest lecturer: Jon Bergmann)

Gravity is really an equation: $F=G[(m_1+m_2)/r^2]$. F is the force, G is the gravitational constant (a number determined by scientists to make the formula accurate). What do the "m"s represent? _____ What is

"r"? _____

What this actually means is that, "Everything is _____."

When you drop a rock from a cliff, which of the following happens?

- A Only the rock falls to the Earth.
- B Only the Earth falls up to meet the rock.
- C The rock and the Earth fall towards each other.
- D None of the above.

If you place two teenagers with equal mass in space:

- A They will fall towards each other.
- B They will remain in place.
- C They will move apart.
- D We cannot even make an educated guess about what will happen.

Why do astronauts weigh less on the moon than they do on the earth?

- A It's a little known fact, but space suits generally make people weigh less.
- B The moon has less mass than the Earth. Therefore, it has a smaller gravitational pull on the astronaut.
- C The Earth is closer to the sun.
- D Astronauts weigh the same no matter where they are.

What causes gravity?

- A The force of magnetism.
- B The amount of electrons in a particular object.
- C We don't know, conclusively.
- D Scientists determine the amount that objects are attracted to one another.

The video uses magnets as an analogy to gravity. In what ways are magnetism and gravity the same? In what ways are they different?

POTENTIAL AND KINETIC ENERGY (Guest lecturers: Nick and Jane)

Gravitational Potential Energy (GPE) is the energy gained by an object as its height _____.

$$GPE = mgh$$

Where, **m** is the _____ of the object, **g** is the _____ field strength, and **h** is the vertical _____ gain.

The **units** for GPE should be _____, mass should be _____, and height should be _____.

Kinetic Energy (KE) is the energy a _____ object has.

$$KE = \frac{1}{2}mv^2$$

Where **m** is the _____ of the object, and **v** is the _____.

The **units** for KE should be _____, mass should be _____, and velocity should be _____.

A rollercoaster's GPE at the top of the hill gets _____ to KE at the bottom.

Write the formula for speed:

How are speed and velocity related?

Compare learning from Jon Bergmann and Nick and Jane to learning about the same concepts in class.

What aspects of the videos did you like?

What, if anything, do you think a "live" teacher could have done better?

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TECHNOLOGY

It's your birthday. You finally get the new smartphone you've been asking for. You jump up in excitement to give your parents a big hug and...it falls out of your hand and hits the cement floor! (You always celebrate in your basement, don't you?) Now, you have a smartphone with a cracked screen. You experience sheer agony. You think to yourself, "I don't ever want something like this to happen to anyone again!" Thankfully, you know how to think like an engineer!



You've identified your problem. You need to find a way to reduce the force of impact if a smartphone falls, so you won't end up with a cracked screen.

Brainstorm and write down several ideas to solve your problem.

Circle your best idea.

Sketch a design. Label it.

Write a description of how your design will work.

List the materials it will be made from (and why).

Explain why you chose this design. (Imagine you're trying to get a company to manufacture it.)

Project Oops! I Dropped Something! ENGINEERING

Don't drop the ball on this one! You've been hired by an engineering firm to figure out how to reduce the force of falling objects that they will be using in a kinetic sculpture. You'll be testing three different objects by dropping them from different heights. You must work together to accomplish this task quickly and accurately! There are deadlines, you know!



You and your team need to:

1. Measure the **mass** of each object. Don't forget to convert from grams to kilograms by moving the decimal point three places to the left!
2. Measure the **height** of the locations of each of the levels of the sculpture (as marked by the tape on the wall). Record your measurements in meters (be accurate to the hundredths place-centimeters).
3. Drop each object from each of the sculpture levels.
4. Record the amount of **time** it takes in seconds for the object to reach the bottom level (floor level).
5. Determine the **relative force** you feel by catching the object near the floor. (Rate it on a scale of 1-6, 1 being the least force, 6 being the most).



The Force of Falling Objects

Object	Mass	Height	Time	Force

Which two variables could you adjust to reduce the force of impact?

What items will you recommend to be used in the kinetic sculpture? Why?

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MATHEMATICS

Why would a smartphone screen break or disintegrate into multiple pieces if it was dropped onto a hard floor? How fast would it be going, how much energy would be transferred to the phone when it stopped so abruptly, and how long would it take to fall? Remember, it's not the fall but the sudden stop at the floor that breaks the phone. These calculations might give you ideas about protecting a precious new 'techno-gadget'. Use the formulas below to calculate some meters per second (velocity), Joules (energy), and seconds (fall time). These formulas will give you more exact numbers than you measured (or will measure) in the Science station and can be used to check your measurement techniques.



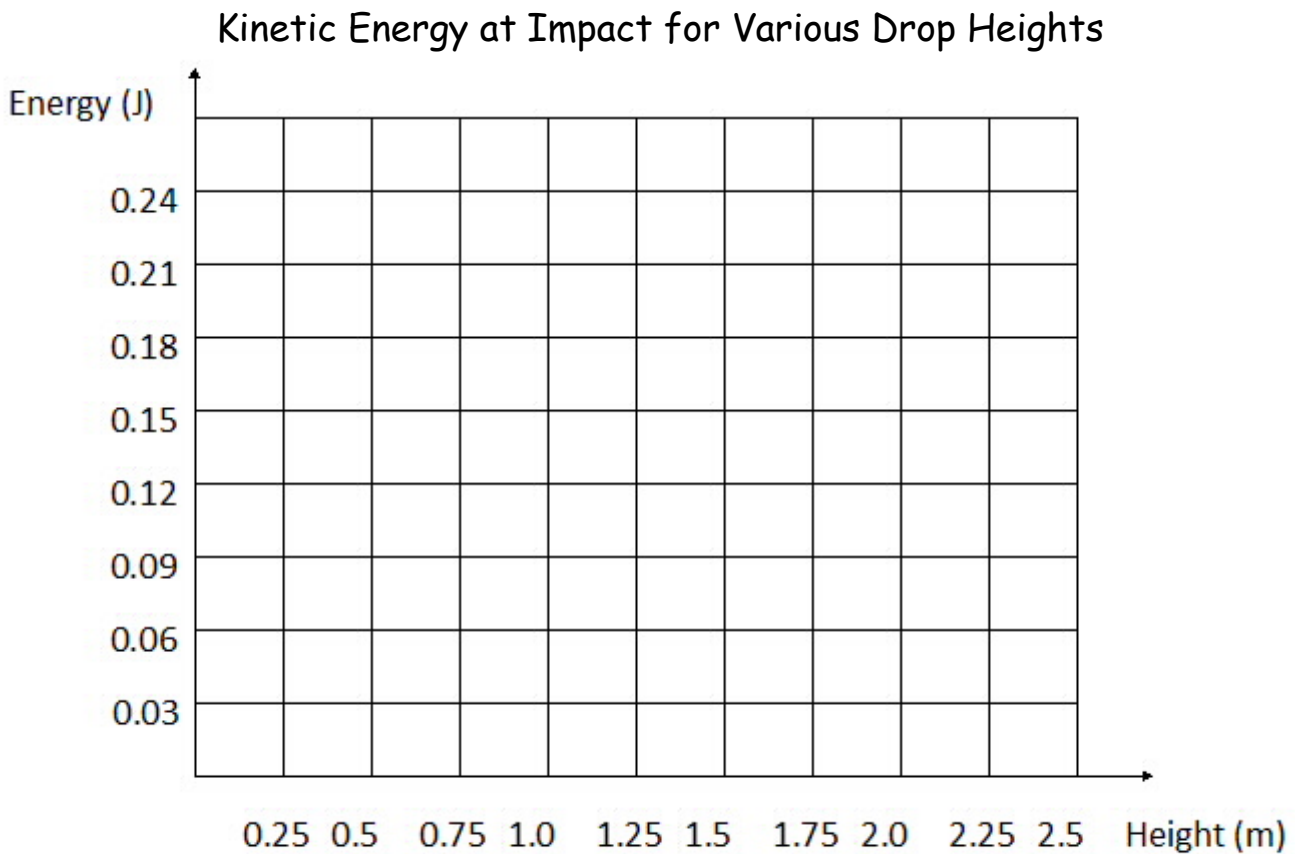
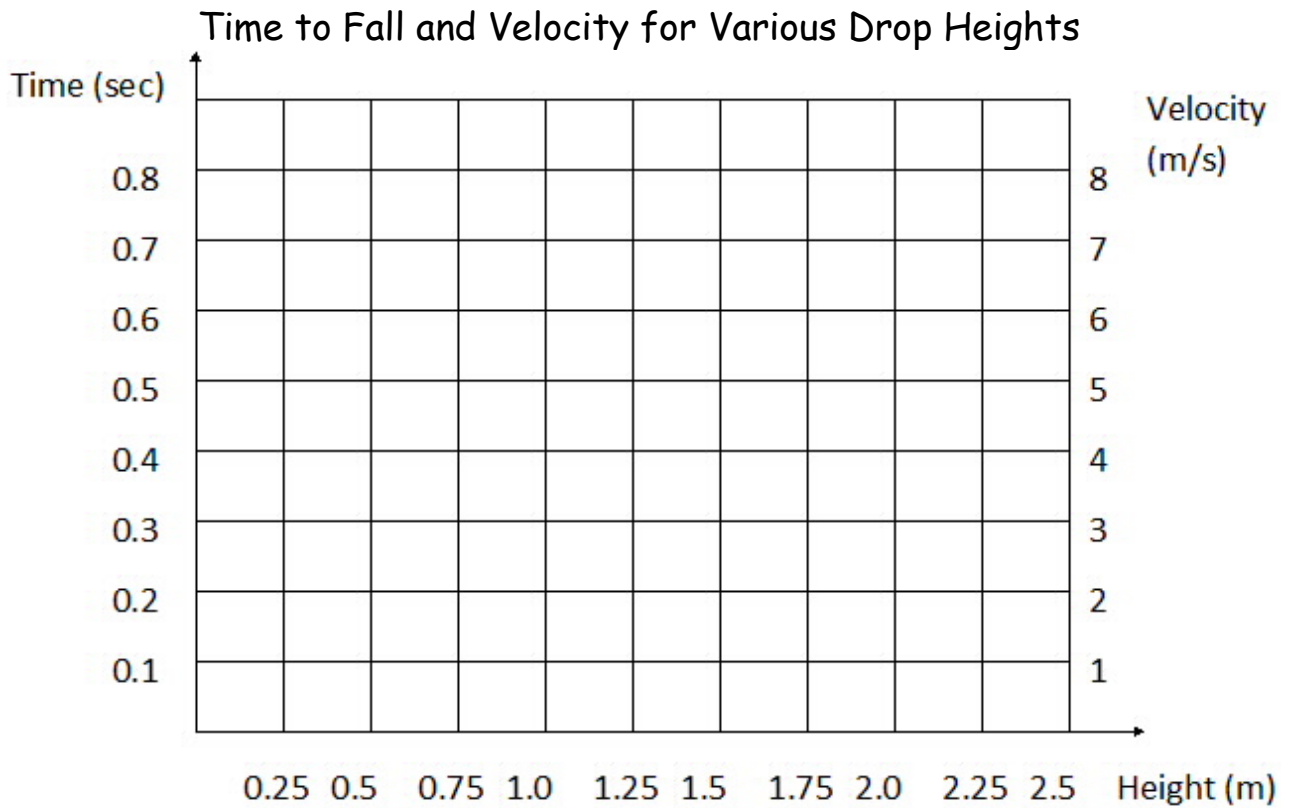
1. Choose one of your objects. Enter the 3 heights it was dropped from into the table. Sample data is available if you have not yet been to the Science station.

Object _____ Mass _____

2. Using the formulas provided, calculate the fall time, impact velocity, potential energy and kinetic energy. Use gravitational acceleration: $g=9.8 \text{ m/s}^2$. (Remember to do calculations in parentheses first.) Report height to the hundredths place, time and velocity to the tenths place, and energy to the hundredths place.

Height (h) (meters)	Fall Time (t) $t=\sqrt{2h/g}$ (seconds)	Velocity (v) $v=gt$ (meters/second)	Potential Energy (PE) $PE=mgh$ (Joules)	Kinetic Energy (KE) $KE=0.5mv^2$ (Joules)
Example: 2.50 m (0.002kg object)	$\sqrt{2h/g}=\sqrt{2*2.50/9.8}$ $t=0.7 \text{ s}$	$gt=9.8*0.7$ $v=6.9 \text{ m/s}$	$mgh=0.002*9.8*2.50$ $PE=0.05 \text{ J}$	$0.5mv^2=0.5*0.002*6.9^2$ $KE=0.05 \text{ J}$

3. Plot your data on the graphs below:



4. What do you notice about the potential and kinetic energy values you calculated?
5. Which height had the most kinetic energy?
6. How high a drop should you design for to protect your smartphone? Why?
7. Why don't all the heights cause the same impact (kinetic) energy, isn't the mass of the object the same for all three drops?
8. What part of the formula for Kinetic Energy (KE) changes for each height?
9. Miles per hour is a unit of speed you can relate to since you ride in cars and are familiar with these units. Convert the maximum velocity your object traveled to miles per hour. Use the conversion for meters/sec to miles/hr of 2.24 mph for 1 meter/second.

(mph = meters/sec X 2.24) Maximum Velocity = _____ mph

10. Is this velocity fast or slow relative to how fast you travel in a car? Would your car receive any damage if it had an accident at this speed?
11. If you could only choose one, would you rather have a smartphone or a car? Why?